VI. ITCT program components

A. International Global Atmospheric Chemistry (IGAC) Program

IGAC is a Core Project of the International Geosphere-Biosphere Program (*IGBP*). The *IGAC* (http://web.mit.edu/afs/athena.mit.edu/org/i/igac/www/index.html) program is focused on understanding the chemistry of the global atmosphere as it relates, in part, to the assimulative (i.e. oxidizing) capacity of the atmosphere and the impact of atmospheric composition on climate and climate on atmospheric composition. The *IGAC* program has several projects that address key aspects of the chemistry of the globe, as well as crosscutting activities that support all projects (*IGAC*, 1998). The research activities of the *IGAC* program are in various stages of readiness; many are underway now and others are still being planned

B. NASA Global Tropospheric Experiment and Earth Observing System

The NASA contribution to the *IGAC/ITCT* is through the Global Tropospheric Experiment (GTE) and the Earth Observing System (EOS). The GTE program supports aircraft missions aimed at understanding natural and anthropogenic influences on the global composition of the troposphere. The next mission, Transport and Chemical Evolution over the Pacific (TRACE-P; http://www-gte.larc.nasa.gov/gte_fld.htm#TRACE), will take place in March-April and is strongly focused on the first two ITCT questions (section 3). The objectives of TRACE-P are: (1) to better understand and quantify the export of environmentally important gases and aerosols, and their precursors, from the Asian continent; and (2) to better understand the processes controlling the chemical evolution of the Asian outflow over the western Pacific. TRACE-P will use two NASA aircraft, the DC-8 (ceiling 12 km) and the P-3B (ceiling 7 km) operating out of Yokota Air Force Base (near Tokyo, Japan) and Hong Kong. Four chemical forecast models will operate continuously during the mission to guide the day-to-day flight planning so that the TRACE-P measurements may provide the best possible test of the models. Near-real-time satellite measurements from AVHRR, SEAWIFS, GOME, TOMS, and MOPITT will provide additional information to guide the flight plan and to place the aircraft observations in context.

A future mission under consideration by GTE for summer 2004 is the Intercontinental Chemical Transport Experiment (INTEX). INTEX will focus on North America, analyzing chemical outflow/inflow and investigating the associated continental boundary layer chemistry

and ventilation processes. It will continue and expand upon the research conducted as part of NARE. The experimental design involves several aircraft operating over the United States and oceanic outflow/inflow regions from bases in Maine, Wisconsin, and California. It also involves ground-based stations in the United States to provide continuous measurements of surface composition, and satellite measurements to place the limited aircraft measurements in a larger-scale context. Beyond ITCT, the scientific objectives of INTEX are directly relevant to the carbon cycle research community; INTEX is thus expected to benefit from collaborations with other NASA programs and across agencies.

The EOS program at NASA supports satellite missions that are of direct interest to ITCT. The CO measurements from the MOPITT instrument, presently in space aboard the Terra satellite, will provide important information on chemical outflow from industrial continents and intercontinental transport of pollution plumes. The TES Fourier transform spectrometer (FTS) instrument, to be launched aboard the Aura satellite in mid-2003, will provide vertical profiles of both ozone and CO in the troposphere. Terra and Aura are polar orbiters; they give global coverage but with relatively sparse temporal density. The GIFTS instrument, presently being developed as a technology demonstration through the NASA New Millennium Program (NMP), will launch the TES FTS technology into geostationary orbit in 2004 and provide continuous mapping of ozone and CO over large scenes (up to 1/6 of the globe). The technology developed through GIFTS could eventually allow for continuous monitoring of chemical outflow from major source regions.

C. ACE (Aerosol Characterization Experiment) – Asia

IGAC has planned a series of Aerosol Characterization Experiments (ACE) that integrate in-situ measurements, satellite observations, and models to reduce the uncertainty in calculations of the climate forcing due to aerosol particles. ACE-Asia is the fourth in this series of experiments and will consist of three focused components in the 2001-2004 timeframe:

1. In-situ and column integrated measurements at a network of ground stations will quantify the chemical, physical and radiative properties of aerosols in the ACE-Asia study area and assess their spatial and temporal (seasonal and inter-annual) variability (2001-2004).
2. An intensive field study will be used to quantify the spatial and vertical distribution of aerosol properties, the processes controlling their formation, evolution and fate, and the

column integrated clear-sky radiative effect of the aerosol (Late March through April, 2001).

3. The effect of clouds on aerosol properties and the effect of aerosols on cloud properties (indirect aerosol effect) will be quantified in focused intensive experiments (Spring 2001 and Spring 2002 or 2003).

ACE-Asia has been divided into these three separate components so that measurement campaigns can be carefully focused to address the goals of each component. This structure acknowledges that the various components are in different stages of scientific readiness and have different instrumental, sampling, meteorological, and logistical needs. Each of the focused components of ACE-Asia will have its own Science and Implementation Plan to elaborate its goals, research plan, needed measurements, platforms and investigators.

The ACE-Asia research program involves scientists from several countries including: Australia, China, Japan, United Kingdom, United States, and South Korea. Support for the U.S. participation has come from several federal agencies: National Oceanic and Atmospheric Administration (NOAA), National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), and Department of Energy (DOE). The research team also includes a large number of university scientists, both from the U.S. and abroad.

The ACE-Asia intensive field study will take place in early spring, 2001 at the same time as TRACE-P. The overall goal of ACE-Asia is to reduce the uncertainty in climate forcing caused by aerosols over Eastern Asia and the Northwest Pacific and to develop a quantitative understanding of the multi-phase gas/aerosol particle/cloud system. ACE-Asia will involve two years of observations from a surface network, in addition to springtime intensive observations with aircraft and ships in 2000 and 2001. Since the goals of TRACE-P and ACE-Asia are complementary, collaboration has been encouraged while maintaining the integrity and independence of each mission.

D. The Atmospheric Chemistry Project of NOAA's Climate and Global Change Program

The Climate and Global Change (CGC) Program is an initiative within NOAA that coordinates and supports relevant NOAA research. The Atmospheric Chemistry Project of CGC continues to direct its grant support to research that aids projects of the *IGAC* Program, particularly the *ITCT* research program (http://www.al.noaa.gov/WWWHD/pubdocs/ITCT/).

NOAA is augmenting the IGAC/ITCT activities by developing capabilities to better quantify the transport of pollution into and from North America. Emissions from North America can impact European air quality. In addition, pollutants transported into the U.S. become part of the "background" that defines a limit for air quality management. The research is focussed on the long-lived pollutants, CO, ozone and fine particles. The research attempts to define the location of the sources of the pollutants and determine the nature of those sources. These sources include natural sources, such as forest fires, volcanoes, and wind-blown dust; manmade sources, such as transportation and heavy industry; and in-route sources, including ships and aircraft. Research conducted to date has focused on modeling studies of impacts from biomass burning and transport from Asia to North America and measurements and modeling of transport and chemistry in the North Atlantic region (NARE). The proposed research will investigate transport across the Pacific and Atlantic Oceans and North Polar Region. In addition, the chemical transformation and deposition that may occur in the oceanic and polar regions will be studied. The program will:

- conduct airborne exploratory studies of airflow from the Pacific into the western U.S. in early 2001,
- develop surface monitoring capabilities and deploy an intensive field study in 2002 to investigate and quantify trans-Pacific transport,
- build on existing modeling efforts to quantify transport of pollution from Asia to North America, and
- analyze existing data and conduct further measurements to determine the influence of biomass burning.

E. European Export of Precursors and Ozone by Long-Range Transport: A Study in EUROTRAC-2 (EXPORT-E2)

The *EXPORT-E2* project is intended to coordinate European activities in *ITCT* and in doing so to raise the profile of this phenomenon with policy makers. It will build on the recent experience of a major aircraft campaign held at DLR Oberpfaffenhofen where three aircraft (UK Meteorological Office C-130, DLR Falcon, and CNRS Mystère) investigated various aspects of the transport of pollution from Europe in well-defined meteorological events (*EXPORT*).

F. BIBLE

The Biomass Burning and Lightning Experiment (BIBLE) Phase C, conducted by the Japanese Earth Observation Research Center (EORC), National Space Development Agency of Japan (NASDA) is scheduled to conduct measurements in the Western Pacific during December 2000 which will provide data supplemental to the TRACE-P mission. The goal of BIBLE is to study tropospheric chemistry (natural and anthropogenic processes) in the tropical Asia/Pacific region. Measurements of ozone, ozone precursors and other photochemical quantities will be made aboard a Gulfstream II aircraft. In addition, BIBLE Phase C will be making measurements of lightning over the Western Pacific during the ferry flights to and from Northern Australia and Indonesia.

G. PEACE

The Pacific Exploration of Asian Continental Emission (PEACE) mission, also conducted by EORC/NASDA, will take place in January 2002 and will also provide data complementary to TRACE-P. Using the Gulfstream-II aircraft mentioned in the previous section, PEACE will make measurements of the seasonal excursion of the continental outflow from Asia.

H. PHOBEA

The recently conducted Photochemical Ozone Budget of the Eastern North Pacific Atmosphere (PHOBEA) aircraft campaign off the northwest coast of the United States in April-May 1999 (http://weber.u.washington.edu/~djaffe/phobea/) revealed layers of high ozone and aerosols transported across the north Pacific from the Asian continent (D. Jaffe is the PHOBEA mission scientist). A second PHOBEA mission conducted concurrently with TRACE-P would be of great value for investigating the long-range transport and chemical evolution of the Asian outflow sampled with the TRACE-P aircraft

I. Pico International Chemical Observatory, a component of the North Atlantic Regional Experiment (PICO-NARE)

A two-year study of atmospheric chemistry in the lower free troposphere (FT) over the Azores is being organized by Richard Honrath of Michigan Technological University (http://www.cee.mtu.edu/~reh/azores/pico). The objective of this project to make direct

measurements over the North Atlantic of pollutants transported from North America and. Since most transport occurs in the free troposphere, these measurements must be made above the marine boundary layer (≈ 2 km). In the entire central North Atlantic, there is only one mountain that reaches above this altitude: Pico. We therefore will make measurements from the summit of Pico for a 2-year period, in order to determine the frequency and magnitude of transport events that disperse ozone and carbon monoxide. Additional measurements will be made by collaborating researchers from Portugal and the U.S., to the extent possible within the station's space and power constraints.

The site will be operated by Michigan Technological University and funded by U.S. National Oceanic and Atmospheric Administration (NOAA). Setup of the semi-permanent measurement site on Pico requires the development of research collaborations with, and granting of permissions by, scientists and government officials in the Azores Islands and in mainland Portugal. These collaborations are established and the measurement site on Pico will be initiated in the summer of 2001. It is expected that this site will form the basis for continuing measurements beyond the period the two year period currently funded.

J. Pacific Landfalling Jets Experiment (PACJET)

The *PACJET* study (http://www.etl.noaa.gov/programs/pacjet/) will be carried out in January and February, 2001 to develop and test methods to improve short-term forecasts of damaging weather on the U. S. West Coast in landfalling winter storms emerging from the meteorological data sparse Pacific Ocean. Instrumentation for measurement of ozone and carbon monoxide will be included to collect an exploratory *ITCT* data set.